UNITED STATES SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN that I, Gunther Schiller, a citizen of Germany, having an address of Westpreussenstrasse 7, D-65582 Diez, Germany, have invented certain new and useful improvements in a

DEVICE AND METHOD FOR THE PRODUCTION OF A MULTI-LAYER CONCRETE PIPE

of which the following is a specification.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a device for the production of a multi-layer concrete pipe, particularly a two-layer concrete pipe. The device has a first stand, in which a first compacting tool such as a pressing head is mounted, a turntable, on which several mold mantles stand vertically and can be pivoted into a stand in cycles, and a first charging system for filling a first concrete mixture into one of the mold mantles. Furthermore, the invention relates to a method for the production of a multi-layer pipe.

2. The Prior Art

Such concrete pipes are used, for example, for municipal and industrial sewer systems. In this connection, the wall of such a pipe fulfills various functions. For example, the wall of the pipe must absorb the static and dynamic stresses that act on it from the outside, and the inside surface is exposed to the medium to be transported. Therefore special properties, such as friction wear resistance, acid resistance, fire resistance, or the like, are often required for the inside surface. It is therefore practical to produce the wall of the pipe from several layers, whereby the layers differ from one another in their properties. In this connection, it is known to line such concrete pipes with an inner layer of an acid-resistant concrete mixture, which increases the resistance of the concrete pipe. Since acid-resistant concrete

mixtures are significantly more expensive than conventional concrete mixtures, only a very thin layer of the acid-resistant concrete is used to line the inside of concrete pipes.

This thin layer of acid-resistant concrete is usually applied using a spin-coating process, in which the acid-resistant concrete mixture is introduced into a pipe that is lying horizontally. In this connection, the working step of spin-coating has to be carried out until the concrete has cured, at least in part, so that the pipe can be removed from the mold in a horizontal position, without being damaged. Since the horizontal production of pipes is very time-consuming, single-layer pipes are often produced using vertical production methods, as well, using a pressing head or the like. In the case of pipes produced vertically, coatings are applied to the inside surface subsequently, or so-called liners made of plastic are installed. The installation of these coatings, some of which are very expensive, requires additional production steps. In addition, there is no intimate connection, i.e. no chemical connection between the layers, so that over the course of time, these layers can separate.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a device and a method of the type stated initially, with which multi-layer concrete pipes can be produced more quickly and

more economically and the connection between the individual layers is improved.

This object is accomplished, according to the invention, essentially in that a second compacting tool that can be driven, having an outside diameter that is smaller than that of the first compacting tool, and a second charging system for filling a second concrete mixture into one of the mold mantles, are provided in the device. By means of this configuration according to the invention, it is possible to provide an outer layer of a first concrete mixture with an inner second layer of a concrete mixture that is acid-resistant. The two layers are each produced by a compacting tool. In this way, the second, inner layer can be applied directly to the first, outer layer, before the outer layer has cured. In this manner, a particularly good connection between the two layers is possible. The thickness of the second, inner layer is determined by the different diameters of the compacting tools, for example the pressing heads. At the same time, particularly efficient production of multi-layer concrete pipes is possible with the device according to the invention, since the pipes produced in this manner can be removed from the mold immediately after the compacting process and before the pipes have cured.

According to a preferred embodiment of the invention, a second stand, in which the second compacting tool is mounted so that it can be driven, is assigned to the first stand, in such a

manner that mold mantles can be pivoted into the second stand from the first stand, by way of the turntable, in cycles. For this purpose, the second stand is arranged in the vicinity of the first stand, so that a mold mantle can be pivoted out of the first stand and pivoted into the second stand by way of the turntable. In this connection, each stand can also have a turntable. The turntables are connected with one another by way of a suitable transport device. After the production of the outer layer of a concrete pipe in the first stand, the pipe, together with the mold mantle, is pivoted into the second stand by way of the turntable, in which the inner coating, for example of acid-resistant concrete, is produced by the second compacting tool. In this arrangement, any tool change that might be necessary between the production of the first, outer layer and the second, inner layer of the concrete pipe can be eliminated. The cycle times in the production of a multi-layer pipe can be further reduced in this manner.

In a further development of this idea, the first charging system is assigned to the first stand and the second charging system is assigned to the second stand. Consequently, in this embodiment two stands, each of them having a charging system for supplying a concrete mixture and a compacting tool, are arranged next to one another, in such a manner that they are connected by way of a common turntable or by way of two turntables connected via a transport device.

As an alternative to this, is it possible, according to another embodiment of the invention, to assign the first and second charging system to the same stand, in which the first and second compacting tool are also mounted alternately, if applicable. In this embodiment, the space requirement of such a device for the production of multi-layer concrete pipes is less than in the case of the device with two stands described above. However, with this embodiment, the production of a multi-layer concrete pipe might make a tool change necessary, since the first, outer layer of the concrete pipe is produced using a compacting tool whose diameter is greater than that of the second compacting tool with which the inner, second layer is produced.

It is preferred if at least one of the charging systems has a concrete silo with a filling belt assigned to it. As an alternative or in addition to this, the charging system can also be formed by a concrete pump having a pump hose. The use of a concrete pump can be sufficient, in particular, for supplying the second concrete mixture, for example a fire-resistant and/or acid-resistant concrete mixture, of which only a small volume proportion is needed for the production of a multi-layer concrete pipe.

In order to shorten the cycle times for the production of a multi-layer concrete pipe, the first and the second compacting tool can preferably be driven alternately in the stand, in cycles, by way of a quick-change device. The change between the first and

the second compacting tool can take place automatically, for example, so that the second (inner) concrete layer can be applied particularly rapidly onto the first, outer concrete layer that has not cured yet.

A tool change as in the device having a stand as described above is not necessary if the second compacting tool is arranged below the first compacting tool, on a common shaft. In this connection, the first and the second charging systems are assigned to the same stand. In this embodiment, the supply of the material for the inner layer preferably takes place from above, through the shaft that drives the compacting tools. A two-layer pipe can thereby be produced in a single production step.

According to another embodiment of the invention, the first and the second charging systems are assigned to the same stand, in which only one compacting tool is mounted, which is radially adjustable. This radially adjustable compacting tool is therefore changeable in its outside diameter. In this way, a pipe having a first inside diameter can first be produced, using the radially adjustable compacting tool. After the outside diameter of the radially adjustable compacting tool has been changed, a further layer having a second inside diameter can be introduced into the pipe. In this embodiment, only one compacting tool is therefore necessary.

A particularly smooth inside wall and a homogeneous concrete distribution in the walls of the pipes to be produced can be achieved in that the compacting tools each have a distributor having several distributor rollers that act essentially radially, a compactor having several pressing rollers that act essentially radially, and a smoothing tool. In this connection, the concrete that is filled into the mold mantle is first uniformly distributed in the mold mantle, and pre-compacted, by means of the distributor rollers of the distributor, so that any reinforcement of the concrete mixture is surrounded. The pressing rollers of the compactor then compact the concrete mixture to such an extent that the desired inside diameter of the concrete pipe is formed. Subsequently, the surface is finished using the smoothing tool, which is preferably configured as a cylindrical piston and is arranged below the compacting tool. As an alternative to the compacting tool described, radially arranged slide rockers can also take over the distribution and compacting of the material.

The formation of torsion moments during the production of the concrete pipe using a pressing head can be avoided in that the distributor of each pressing head rotates about the longitudinal axis of the mold mantle in the opposite direction from the compactor. In this connection, the compactor and the distributor can rotate at different speeds. In this connection, the speed of the distributor is generally clearly higher than that of the compactor having the pressing rollers and the smoothing piston. In

this manner, any reinforcement that might be present in the concrete pipe is also not twisted during the compacting process, so that it remains in its planned position.

According to another exemplary embodiment, a spray head for applying at least one concrete layer can be arranged in the case of at least one compacting tool, above the smoothing tool. The second concrete mixture can be distributed by means of centripetal forces that occur as a result of the rotating movement of the spray head. As a result of the impact velocity of the sprayed material onto the inside surface of the first concrete layer, the material is at least partially compacted. Consequently another distributor and/or a compactor is not necessary.

The invention also comprises a method for the production of a multi-layer concrete pipe, particularly a two-layer concrete pipe, which comprises the following steps: first, a mold mantle standing essentially vertically on a turntable is pivoted into a first stand and the mold mantle is filled with a first concrete mixture from a first charging system. This first concrete mixture is then distributed and compacted in the mold mantle by means of a rotating and vertically displaceable first compacting tool, and the inside surface is smoothed, if necessary. Before the concrete pipe is removed from the mold, a second concrete mixture is filled into the mold mantles that are standing essentially vertically, by means of a second charging system, and the second concrete mixture is

distributed and compacted in the mold mantle, using a second compacting tool, whose diameter is smaller than that of the first compacting tool, and the inside surface is smoothed, if necessary, before the concrete pipe is removed from the mold. In this method, the mold mantle is aligned essentially vertically during the introduction and compacting of both concrete mixtures, so that the pipes produced can be removed from the mold immediately after the compacting process and before the pipes have cured. In this way, not only is it possible to achieve shortened cycle times and therefore a more efficient production of concrete pipes, but also the connection between the individual layers of the concrete pipe is improved, since the first, outer concrete layer cannot cure before the second, inner concrete layer has been applied.

Before the second concrete mixture is filled into the mold mantle and distributed and compacted in it, the first compacting tool is preferably exchanged for the second compacting tool, by way of a quick-change device in the first stand, and that after the second concrete mixture has been filled into the mold mantle and distributed and compacted in it, and the inside surface has been smoothed, the second compacting tool is exchanged for the first compacting tool, by way of a quick-change device in the first stand. In this method, the mold mantle can remain in its essentially vertical position in the stand during the production of both layers. The mold mantle is only pivoted out of the stand, by way of the turntable, after all of the layers of the concrete pipe

have been applied.

As an alternative to this, it is also possible to fill the first concrete mixture from the first charging system into the mold mantle above the first compacting tool, while at essentially the same time, the second concrete mixture is supplied from the second charging system, above the second compacting tool, through the shaft on which the compacting tools are mounted. In this connection, the compacting tools are arranged one below the other. In this way, the second layer is distributed, compacted, and the inside surface is smoothed, immediately after the first layer, so that a quick-change device for the compacting tool is eliminated and the two-layer pipe can be produced in a single work cycle.

According to another embodiment of the method according to the invention, it is provided that before the second concrete mixture is filled into the mold mantle and distributed and compacted in it, the outside diameter of the first compacting tool is reversibly reduced. In this connection, the outside diameter of the compacting tool is radially adjustable. Consequently, only a single radially adjustable compacting tool is necessary for this method. In a first work cycle, the first concrete mixture is filled into the mold mantle, using the first charging system. A first, large outside diameter is set on the radially adjustable compacting tool. At this setting, a pipe having a larger inside diameter is first produced. Afterwards, the compacting tool can be

brought into a starting position. Now, in another work cycle, the second concrete mixture is filled into the mold mantle, using the second charging system. A second outside diameter is set on the compacting tool, which is smaller than the first outside diameter. Using this setting, the second, inner layer having the smaller inside diameter is then applied.

As an alternative to this, it is also possible to pivot the mold mantle on the turntable out of the second stand and to pivot it, standing essentially vertically, into a second stand, before the second concrete mixture is filled into the mold mantle and distributed and compacted in it, and the inside surface is smoothed. The change-over or adjustment of the compacting tools can be eliminated in this way, thereby making the technical fittings of the device significantly simpler.

The method can be carried out in a particularly simple manner, without any additional devices, if the mold mantle is transported from the first stand, essentially standing vertically, to the second stand, and introduced there before the first concrete mixture has cured in the mold mantle. In the second stand, the second concrete mixture is then filled into the mold mantle, and it is distributed, compacted, and smoothed, using the second compacting tool. The change-over of the compacting tool can thereby be eliminated. The only thing necessary is to arrange two machines that work with known vertical pipe production methods

spatially in such a manner that the transport between the machines is possible before the first layer has cured.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings. It is to be understood, however, that the drawings are designed as an illustration only and not as a definition of the limits of the invention.

In the drawings, wherein similar reference characters denote similar elements throughout the several views:

Fig. 1 shows a front view of a device according to a first embodiment of the invention;

Fig. 2 shows a side view of the device according to Fig. 1;

Fig. 3 shows a top view of the device according to Fig. 1;

Fig. 4 shows a front view of a device according to a second embodiment of the invention;

Fig. 5 shows a top view of the device of Fig. 4;

Fig. 6 shows a cross-sectional view of a pipe during production;

Fig. 7 shows a front view of a device according to

another embodiment of the invention;

Fig. 8 shows a top view of the device of Fig. 7;

Fig. 9 shows a front view of a device according to another embodiment of the invention;

Fig. 10 shows a top view of the device of Fig. 9;

Fig. 11 shows a front view of a device according to another embodiment of the invention;

Fig. 12 shows a cross-sectional view of a pipe during production in the device according to Fig. 11; and

Fig. 13 shows a cross-sectional view of a pipe during production in a device according to another embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figures 1 to 3 show a first embodiment of a device 1 that has a stand 2 and a turntable 3 assigned to stand 2. A compacting tool configured as a pressing head 4, which can be displaced within stand 2 in the vertical direction and rotated about its vertical longitudinal axis, is mounted in stand 2.

Two mold mantles 5a and 5b are arranged on the turntable 3, standing essentially vertically, and mold mantle 5b that is on the right in Fig. 1 has been pivoted into the stand 2. In this position, mold mantle 5b is located vertically below pressing head 4, so that pressing head 4 can be lowered into the mold mantle 5b. By means of a rotation of turntable 3, mold mantle 5b can be pivoted out of stand 2, and mold mantle 5a can be pivoted into

stand 2.

As is particularly evident from the representation in Figures 2 and 3, a first charging system 6 having a concrete silo 6a and a filling belt 6b is arranged in stand 2. Furthermore, a second charging system 7 having a second concrete silo 7a and a second filling belt 7b is positioned in stand 2. In this connection, filling belts 6b and 7b run from concrete silo 6a or 7a, respectively, to a position above mold mantle 5b that is pivoted into stand 2, so that in each instance, a concrete mixture can be filled into mold mantle 5b via charging systems 6 and 7.

The embodiment of the device 1' shown in Figures 4 and 5 essentially corresponds to the embodiments of Figures 1 to 3, whereby the same components are provided with the same reference numbers. Stand 2 of device 1' has a turntable 3 assigned to it, on which a mold mantle 5b that is pivoted into stand 2 and a second mold mantle 5a are positioned. Above mold mantle 5b, a pressing head 4 is arranged in stand 2. In addition, a first charging system 6 for filling a first concrete mixture into mold mantle 5b is arranged in stand 2, and has a concrete silo 6a and a filling belt 6b.

Furthermore, a second charging system 8 for filling a second concrete mixture into mold mantle 5b is provided in device 1'. In this connection, second charging system 8 has a concrete pump 8a,

which is connected with a pump hose 8b, which in turn ends at the top of mold mantle 5b, so that the second concrete mixture can be filled into mold mantle 5b from pump hose 8b.

In the embodiment shown in Fig. 7 and 8, a second stand 2' is arranged next to first stand 2, in such a manner that mold mantles 5a, 5b can be pivoted out of first stand 2 directly into second stand 2', by way of the turntable 3, and vice versa. In this connection, each of stands 2, 2' is equipped with a charging system 6 or 7, respectively, and a pressing head 4 or 4', respectively. Pressing heads 4, 4' have different diameters, in order to form layers 9a, 9b of the pipe 9. The construction space of the device shown is therefore very slight, and multi-layer pipes 9 can be produced at a high cycle number.

If the arrangement of stands 2 and 2' directly next to one another, as described with reference to Fig. 7 and 8, is not possible for space reasons, stands 2 and 2' can also be positioned at a distance from one another, as shown in Fig. 9 and 10. In this connection, each stand 2, 2' is equipped with a separate turntable 3, 3', a charging system 6 or 7, respectively, and a pressing head 4 or 4', respectively. A transport device indicated by the double arrows is provided between stands 2, 2', by means of which mold mantles 5a, 5b can be transported from first stand 2 into second stand 2' and vice versa. In this manner, it is also possible to retrofit a device for the production of a single-layer pipe, having

a single stand 2, by providing an additional stand 2' having a second charging system 7, in such a manner that multi-layer pipes 9 can be produced.

Fig. 6 shows two production steps in the production of a two-layer concrete pipe 9, whereby the right half shows the compacting of the first, outer layer 9a, using first pressing head 4, while the left half of Fig. 6 shows application of the second, inner layer 9b, using compacting tool configured as a pressing head 4'.

Pressing heads 4, 4' are mounted on a shaft 10 and can be moved in the vertical direction by means of the shaft 10. Each of the two pressing heads 4, 4' has several distributor rollers 11, 11', several compacting rollers or pressing rollers 12, 12', and smoothing pistons 13, 13'. In this connection, distributor rollers 11, 11' run about shaft 10 at a high speed, and thereby distribute the concrete that is filled into mold mantle 5b at the top on the wall of mold mantle 5b, in the radial direction. Pressing rollers 12, 12', which together describe a larger diameter than distributor rollers 11, 11', run at a lower speed, together with smoothing pistons 13, 13', and in the opposite direction to the distributor rollers 11, 11', about shaft 10. As shown in Fig. 6, the concrete is compacted and smoothed on the walls of mold mantle 5b, in this process.

In the following, the method for the production of multi-layer

concrete pipes 9 will now be explained. First, an empty mold mantle 5b is pivoted into the position within the stand 2 shown in the figures, by way of turntable 3. A first concrete mixture is filled into mold mantle 5b by means of first charging system 6, from concrete silo 6a, by way of the filling belt 6b. At the same time, first pressing head 4 in stand 2 is lowered down into mold mantle 5b, so that the first concrete mixture is distributed and compacted in mold mantle 5b by first pressing head 4. By filling in additional concrete and, at the same time, rotating and lifting pressing head 4 within mold mantle 5b, a single-layer concrete pipe 9a is formed in this manner, from the bottom to the top.

When concrete pipe 9a in mold mantle 5b is finished, the supply of the first concrete mixture from concrete silo 6a is stopped, and pressing head 4 is moved completely out of mold mantle 5b. First pressing head 4 is then replaced with a second pressing head 4', for example by way of a quick-change device, the diameter d_2 of which is smaller than the diameter d_1 of the first pressing head 4. This second pressing head 4' is then lowered into mold mantle 5b, while at the same time, a second concrete mixture is filled into mold mantle 5b from the second concrete silo 7a, by way of filling belt 7b or concrete pump 8a and pump hose 8b, which mixture is distributed and compacted by pressing head 4'. In this connection, the second concrete mixture combines with the first concrete mixture in the mold mantle 5b, which has not cured yet, so that a two-layer concrete pipe 9a, 9b is formed.

When second pressing head 4' has also been completely moved out of mold mantle 5b, towards the top, the finished concrete pipe 9 in mold mantle 5b on turntable 3 can be pivoted out of the stand 2, whereby at the same time, an empty mold mantle 5a is pivoted into stand 2. Now, two-layer concrete pipe 9 can be transported to the curing location and can be removed from the mold mantle before curing, if necessary.

As an alternative to this method, it is also possible to pivot mold mantle 5b, by means of turntable 3, out of stand 2 after the production of the first, outer layer 9a of concrete pipe 9 by means of pressing head 4 in stand 2, and to pivot it into a stand 2' as shown in Fig. 7 and 8, or, as indicated in Fig. 9 and 10, to transport it to a second stand 2', in which the second, inner layer 9b is produced, using a second pressing head 4' and a second charging system. In the same manner, concrete pipes with additional inner layers can also be produced. In this connection, the concrete pipes can have a reinforcement, for example a cage made of steel wire.

Another embodiment of the device for the production of a two-layer concrete pipe 9 is shown in Fig. 11. For this purpose, two charging systems 6 and 8 are provided in stand 2, next to turntable 3 for pivoting a mold mantle 5 in and out, whereby charging system 8 for the second concrete mixture has a concrete pump 8a that is connected with a pump hose 8b, which opens into a hollow shaft 10'.

A first compacting tool 4 and, vertically below it, a second compacting tool 4' are mounted on the hollow shaft 10'.

As shown in Fig. 11, the first compacting tool, which is configured as a pressing head 4, has several distributor rollers 11, several compacting rollers or pressing rollers 12, and a smoothing piston 13. In this connection, the distributor rollers 11 run about the shaft 10' at a high speed, and thereby distribute the concrete that is filled into the mold mantle 5 from the top on the wall of the mold mantle 5, in the radial direction. Pressing rollers 12, which together describe a larger diameter than distributor rollers 11, run at a lower speed, together with the smoothing piston 13, and in the opposite direction to distributor rollers 11, about shaft 10', so that the first concrete mixture is compacted and smoothed on the walls of mold mantle 5, in this process, as outer layer 9a.

In the same manner, the second compacting tool, which is also configured as a pressing head 4', also has several compacting rollers or pressing rollers 12' and a smoothing piston 13'. An exit opening is provided in hollow shaft 10', between first pressing head 4 and second pressing head 4', through which the second concrete mixture is introduced into mold mantle 5 from pump 8a. Pressing rollers 12', which together describe a smaller diameter d_2 than the first smoothing piston 13, run about shaft 10' together with second smoothing piston 13', so that the second

concrete mixture is compacted and smoothed on the wall of the mold mantle 5, in this process, as inner layer 9b. In this manner, two-layer pipe 9 is produced in one work step. The transport of the mold mantles between two stands 2, 2' as described above, as well as a tool change between the processing steps, can therefore be eliminated.

As an alternative to this, the second concrete mixture can be applied as an inner layer 9b, for example, by way of a spray head 14 shown in Fig. 13, which is provided on hollow shaft 10' below the smoothing piston 13 of the first pressing head 4. By means of the pressure generated by the pump 8a, as well as centripetal forces, the second concrete mixture is firmly connected with the outer layer 9a when it impacts the latter. It is therefore not necessary to provide distributor rollers 11' or pressing rollers 12' in second pressing head 4'. Inner layer 9b is smoothed by smoothing piston 13' of second pressing head 4'.

Reference Symbol List

1, 1'	device
2, 2'	stand
3, 3'	turntable
4	first pressing head (compacting tool)
4'	second pressing head (compacting tool)
5, 5a, 5b	mold mantle
6	first charging system
6a	concrete silo
6b	filling belt
7	second charging system
7a	concrete silo
7b	filling belt
8	second charging system
8a	concrete pump
8b	pump hose
9	concrete pipe
9a	first, outer layer
9b	second, inner layer
10	shaft
10'	hollow shaft
11, 11'	distributor roller
12, 12'	pressing roller (compacting roller)
13, 13'	smoothing piston (smoothing tool)
14	spray head

d_1 inside diameter of the outer layer 9a

d_2 inside diameter of the inner layer 9b